## REMARKS

In response to the non-final Office Action mailed on October 3, 2002, Applicant wishes to enter the following remarks for the Examiner's consideration. Applicant has amended claims 22 and 27. Claims 22, 27, and 28 are pending in the application.

The Information Disclosure Statement filed March 8, 1999 has not been considered by the Examiner, for the reason that a list of all patents, publications or other information submitted was thought to not have been submitted. A PTO Form 1449 was in fact submitted, as indicated by the return receipt postcard that was mailed in with the CPA on March 8, 1999, a copy of which is attached to this response. As the IDS was properly submitted, Applicant respectfully requests that the Examiner consider the references cited to the Office at his earliest convenience.

Claim 22 is rejected under 35 U.S.C. 112, second paragraph, as being indefinite. Applicant has amended claim 22 to provide antecedent basis for a transfer function of the system and appreciates the Examiner bringing this to the Applicant's attention.

Claims 22, 27, and 28 are rejected under 35 U.S.C. §102(b) as being anticipated by Allie et al. (the Allie reference, hereinafter) or Lo et al. (hereinafter, Lo) or Saruta et al. (hereinafter Saruta). Applicant respectfully traverses these rejections of the claims.

The claimed invention covers a system and method in which the residual microphone controls the characteristics of a controller whose signal input is connected to an ambient noise sensing microphone in a novel combination of a virtual earth feedback system and a feedforward system. This is quite different from the three cited references in which the ambient noise sensing microphone is connected to the signal

input of the controller to form a more or less conventional adaptive feedforward noise cancellation arrangement. A description of the present invention and the references will make these differences clear.

The Allie, Lo and Saruta references

These references all describe an adaptive feedforward controller system in which an ambient noise sensing microphone produces a signal output representative of the ambient noise, a residual noise sensing microphone produces a signal output representative of the residual noise in the canceling region, and a controller produces an output to a speaker which in turn cancels the component of the ambient noise passing through the acoustics of the system to the canceling region. The controller has a filter that has a signal path from a signal input to a signal output and a transfer function defined as the ratio of the signal path output signal to the signal path input signal. The signal input is connected to the output of the ambient noise sensing microphone and the signal output is connected to the speaker.

In order to effect noise cancellation in such an adaptive feedforward controller system, it is desired that the transfer function from the ambient noise sensing microphone input to the speaker output be such that the speaker output in the canceling region is the inverse of the component of ambient noise that reaches the canceling region. The controller adapts the transfer function of its filter to maximize cancellation effects, thereby countering system acoustics and speaker characteristics that may change over time. This is affected with a control input, obtained from the residual microphone, to the controller which is used to change the transfer function of the controller filter. Reduction in cancellation performance causes the residual microphone output to increase proportionally. This is detected by the controller and is

used to adapt the filter coefficients, by means of a suitable algorithm, thus reducing the residual signal back down again and thus improving cancellation.

It is important to recognize that at no point in these references is the residual microphone output signal provided to the filter and pass through the signal path of the filter. Rather, the residual microphone signal provided at the control input of the controller acts upon the filter and is not acted upon by the controller. The ambient noise microphone output signal, conversely, is connected to the signal path input of the controller/filter and is acted upon by the filter; it does not act upon the controller.

The Present Invention

The present invention describes a novel combination of a virtual earth feedback system and a feedforward system. The controller functionality has two signals paths, a residual noise signal path that originates at a residual noise input terminal/port of the controller and serves a feedback function and an ambient noise signal path that originates at an ambient noise input terminal/port of the controller and serves a feedforward function, which converge at some point within the controller to form the output signal of the controller. The transfer function of the controller and system, therefore, may be considered to have a portion associated with the residual noise signal path and another portion associated with the ambient noise signal path of the controller before the two signal paths converge. The processor thus processes both the signal from the ambient sensor microphone and the signal from the residual microphone. This is in sharp contrast to the cited references in which the residual noise signal is used to adjust the transfer function of the adaptive filter of Allie/Lo/Saruta, which is defined by the ratio of its output signal to the input provided from the ambient noise microphone. The references do not teach that the residual noise signal itself is provided as an input to the adaptive filter to produce an output signal to the speaker.

In the present invention, then, there is at least a residual sensing microphone and a processor/controller/filter having a signal path between a signal input and a signal output, with the signal input of the controller signal path always being connected to at least the signal output of the residual microphone (and optionally also being provided with amplitude indicia of ambient noise). This is an important difference between the references and the present invention. In the present invention, the residual microphone signal output passes through the signal path of the controller; in the cited references, it does not.

The present invention may also incorporate an ambient sensor microphone whose signal output is connected to a further signal input of the controller/filter to pass through the signal path and thus produce a signal output of the controller with an associated transfer function, as noted above. This ambient noise signal path of the controller accomplishes cancellation in the region of the speaker output.

These differences between the present invention and the references cited might be further illustrated by an example in which the ambient noise sensing microphone is disconnected. In the case of the prior art, the cancellation system will fail to function wherein in the present invention there will still be cancellation due to the operation of the virtual earth feedback system and its residual noise signal path discussed above.

The claimed invention recites these differences between the present invention and the cited references. Referring now to Claim 22, this claim recites that the system gain is reduced in response to a reduced ambient noise level. This feature is discussed in the specification. The claim states that the "noise cancellation processor processes the residual signal" The microphone output connects to the signal input of the processor

and is acted upon by the processor. This is quite different from the cited references in which the controller does not process the residual microphone output signal – rather, it is the ambient microphone signal output that is processed by the controller, an important distinction.

Claim 22 further recites "means for generating indicia of the level of ambient noise and responsively varying the transfer function of the system in response to said indicia of ambient noise such that the gain of the system is decreased in response to a decrease in said indicia of amplitude of ambient noise." This is a further distinction between the present invention and the cited references. The cited art teaches that the transfer function of the controller is altered in response to the residual noise level in order to always *improve* cancellation and further reduce it, the goal of an adaptive system. The present invention, conversely, teaches and recites in the claim that if the ambient noise level is reduced, the gain of the system is correspondingly reduced. Since the cancellation performance is proportion to the system gain, reducing system gain in response to reducing ambient noise level will *degrade* cancellation performance. This is reflected in the claims.

The Examiner, in rejecting the claims over Allie, Lo and Saruta, states that these references incorporate "filter means (adaptive filters) contained within the processor that filter the feedback signal for selectively varying the transfer function of the system, wherein the feedback signal is processed by the processor to form a component of the anti-noise field." No support can be found in these references for this assertion and none is given. It is, in fact, incorrect. None of the references teach, disclose, suggest or otherwise anticipate that a feedback signal is filtered by filter means such that the processor processes the feedback signal. Rather, these references teach the opposite – that the feedback signal from the residual microphone acts upon the controller to alter

its transfer function and thereby affect filtering of the signal from the ambient noise microphone only.

Applicant believes that these distinctions are currently in the claims. Moreover, Applicant has additionally amended the claims for sake of clarity to recite that the transfer function is determined by the output signal of the controller to at least the residual signal. As previously discussed, the transfer function may have a component affected by the ambient noise.

With regard to claims 27 and 28, similar arguments may be made. These claims additionally have recitations directed to effective operation at different frequency ranges. The feedforward cancellation operation occurs over predominantly the higher frequency range while the feedback cancellation operation is mainly effective over a lower frequency range, with a substantial overlap between the two regions. This operation is described at length in the specification.

In the present invention, there are two cancellation systems operating in combination – the virtual earth feedback path around the residual microphone, controller and speaker and the feedforward path around the ambient noise sensor, controller and speaker. These two cancellation paths or systems have different frequency ranges of effective operation, referred to as "feeding forward a first range of frequencies that include at least the high frequency components of the ambient noise." Thus, the feedforward process is selective as to the range of frequency components present in the ambient signal on which it operates.

The cited references, however, teach only one cancellation path or system – an adaptive feedforward system in which the controller input and residual noise signals are

different. This separation is required due to the characteristics of the acoustic path from the ambient noise region to the cancellation region and would exist even if the cancellation system were inoperative. Since these signals are separate, and the effectiveness of the cancellation process is unlikely to be equal at all frequencies, the amplitude of the ambient and residual noise will be different at different frequencies. This does not, however, indicate that the frequency ranges are different; the residual noise is merely an attenuated version of the ambient noise and so the range of frequencies present in each will be the same. Applicant must respectfully, but strongly, therefore disagree with the Examiner's assertion from the last office action that "the input noise signal and the residual noise signal are different and inherently with different frequency ranges."

Applicant believes that the foregoing amendments and remarks overcome the prior art rejection over the Allie or Lo or Saruta references and place this application in condition for allowance. Reconsideration and allowance of the claims are therefore respectfully requested at the Examiner's earliest convenience.

Respectfully submitted,

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Please amend the claims as follows:

22. (amended) An active noise canceling system comprising:

a sound generator, responsive to drive signals applied thereto, for generating an anti-noise field;

a noise cancellation processor, for generating the drive signals to the sound generator;

a first sound sensor disposed within said anti-noise field to generate a residual signal indicative of the sum of ambient sounds and anti-noise impinging on the sensor, wherein said noise cancellation processor processes the residual signal to form a component of the anti-noise field; and

means for generating indicia of the level of ambient noise and responsively varying [the]a transfer function of the system in response to said indicia of amplitude of ambient noise such that a gain of the transfer function of the system is decreased in response to a decrease in said indicia of amplitude of ambient noise, wherein the transfer function comprises a ratio of an output signal of the noise cancellation processor to at least the residual signal.

27. (amended) A method for increasing the stability of an active noise cancelling system comprising a noise cancellation circuit, a sound sensor and sound generator cooperating in a feedback loop, the feedback loop having an associated transfer function, the method including the steps of:

generating, in accordance with drive signals, an anti-noise field;

sensing the residual noise resulting from interaction of the anti-noise and ambient noise;

generating the drive signals in accordance with said sensed residual noise;

sensing ambient noise outside of the anti-noise field; and

feeding forward a first range of frequencies that includes at least the high frequency components of the ambient noise to effect feedforward cancellation thereof;

wherein a feedback signal, generated by the feedback loop that processes a second range of frequencies, is processed by a noise cancellation processor without affecting the transfer function of the [feedback loop]noise cancellation processor to form a component of said anti-noise field with the transfer function comprising a ratio of an output signal of the noise cancellation processor to at least said sensed residual noise, and

wherein the first range of frequencies and the second range frequencies substantially overlap in a cancellation band below an enhancement frequency range.